NEOSHO BASIN TOTAL MAXIMUM DAILY LOAD

Waterbody / Assessment Unit: Neosho River Headwaters
Water Quality Impairment: Total Phosphorus

1. INTRODUCTION AND PROBLEM IDENTIFICATION

Subbasin: Neosho Headwaters

County: Morris

HUC 8: 11070201 HUC10 (12): 01 (01, 02)

Ecoregion: Flint Hill, 28

Drainage Area: ~ 107 Square Miles

Main Stem Water Quality Limited Segments:

Station	***Main Stem***	***Tributary***
SC637	Neosho River (23)	Haun Cr (29)
		Parkers Cr (27)
		Neosho R, W Fk (28)
		Level Cr (9023)

2008, 2010, 2012, and 2014 303(d) Listing: Kansas Stream segments monitored by station SC637 are cited as impaired by Total Phosphorus (TP) for the Neosho Basin.

Impaired Use: Expected Aquatic Life, Contact Recreation and Domestic Water Supply

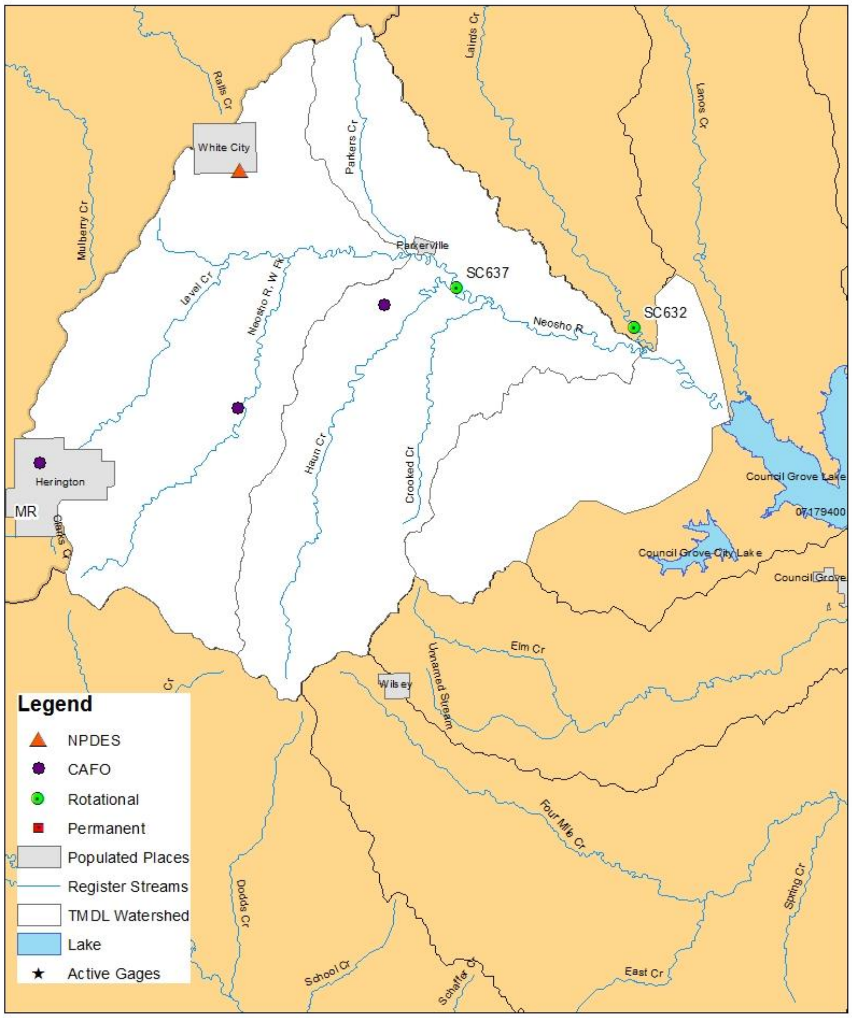
Water Quality Criteria:
Nutrients – Narrative: The introduction of plant nutrients into surface waters designated for domestic water supply use shall be controlled to prevent interference with the production of drinking water (K.A.R. 28-16-28e(c)(3)(D)).

The introduction of plant nutrients into streams, lakes, or wetlands from artificial sources shall be controlled to prevent the accelerated succession or replacement or aquatic biota or the production of undesirable quantities or kinds of aquatic life (K.A.R. 28-16-28e(c)(2)(A)).

The introduction of plant nutrients into surface waters designated for primary or secondary contact recreational use shall be controlled to prevent the development of objectionable concentrations of algae or algal by-products or nuisance growths of submersed, floating, or emergent aquatic vegetation (K.A.R. 28-16-28e(c)(7)(A))

Designated Uses: Expected aquatic life use (Segments: 23, 27, 28, 29, 35, 9023); Primary Contact Recreation C (23, 27, 28, 29); Secondary Contract Recreation b (35, 9023), Drinking Water Supply (23, 27, 28, 29, 35, 9023); Food Procurement (23, 28, 29, 35, 9023); Groundwater Recharge (23, 27, 28, 29, 35, 9023); Industrial Use (23, 27, 28, 29, 35, 9023); Irrigation Use (23, 27, 28, 29, 35, 9023); Livestock Watering Use (23, 27, 28, 29, 35, 9023)

Figure 1. Base Map for Neosho River headwaters at SC637 watershed.



2. CURRENT WATER QUALITY CONDITIONS AND DESIRED ENDPOINT

Level of Support for Designated Uses under 2014-303(d): Phosphorus levels on the Neosho River at SC637 are consistently high. Excessive nutrients are not being controlled and are thus impairing aquatic life, domestic water supply, and contact recreation.

Stream Monitoring Sites and Period of Record: KDHE rotational monitoring station SC637 on the Neosho River is sampled bimonthly or quarterly during the sampling years of: 1992, 1993, 1996, 2000, 2004, 2008, and 2012. WRAPS sampling site SW015, located at the SC637 sampling site, is sampled four or five times per year from March through October by KDHE from 2011-2014. Probabilistic sampling station SPA067 located on Level Creek was sampled three times during 2006.

Hydrology: Long Term Flow conditions for the Neosho River at SC637 were estimated based on regression calculations utilizing the USGS gage 07179300 (2012-2014) on the Neosho River near Parkerville, the USGS gage 06888500 (1990-2014) on Mill Creek near Paxico and the USGS Scientific Investigations Report 2004-5033 (Perry, 2004). Appendix A details the calculations used to develop long term flow conditions at SC637.

Table 1. Long Term Flow conditions as calculated from USGS gages 07179300 and 06888500.

Stream (USGS seg ID)	Drainage Area sq miles	Mean Flow (cfs)	Percent of Flow Exceedance				
			90% (cfs)	75% (cfs)	50% (cfs)	25% (cfs)	10% (cfs)
Neosho R at SC637	74.6	20.14	0	0.57	4.8	12.86	35.55
USGS Estimated Flows (Perry, 2004)							
Neosho R (2436)	97.98	40.48	0	0.64	4.34	15.84	50
Neosho R (2403)	76.03	30.83	0	0.22	2.95	11.22	36.21
Haun Cr (2611)	17.6	7.91	0	0	0.44	2.18	7.98
Parker Cr (2371)	15.03	6.67	0	0	0.19	1.48	6.21
Neosho R, W Fk (2551)	16.59	6.63	0	0	0.06	1.18	5.7
Level Cr (2481)	13.67	5.47	0	0	0	0.7	4.3
Crooked Creek (2530)	13.77	6.8	0	0	0.49	2.09	7.18
Neosho R (2460)	132.31	54.41	0	1.17	6.15	22.07	69.46

Flow duration curves over the period of record from 1990-2013 are illustrated for sampling station SC637 in Figure 2. The estimated average and median flow values at SC637 on the Neosho River are displayed in Figure 3 for the years this station was sampled. Wet weather years, where the annual average and median flows exceed the long term average and median flows, include 1992, 1993, 2004 and 2008. Drier sampling years, where the annual average and median flows are well below the long term average and median flows, occurred in 2000, 2011, 2012, and 2013. The estimated average monthly flows at SC637 are displayed in Figure 4. The average flows are the highest during the months of March, April, May, June, and July.

Figure 2. Flow Duration curve for SC637.

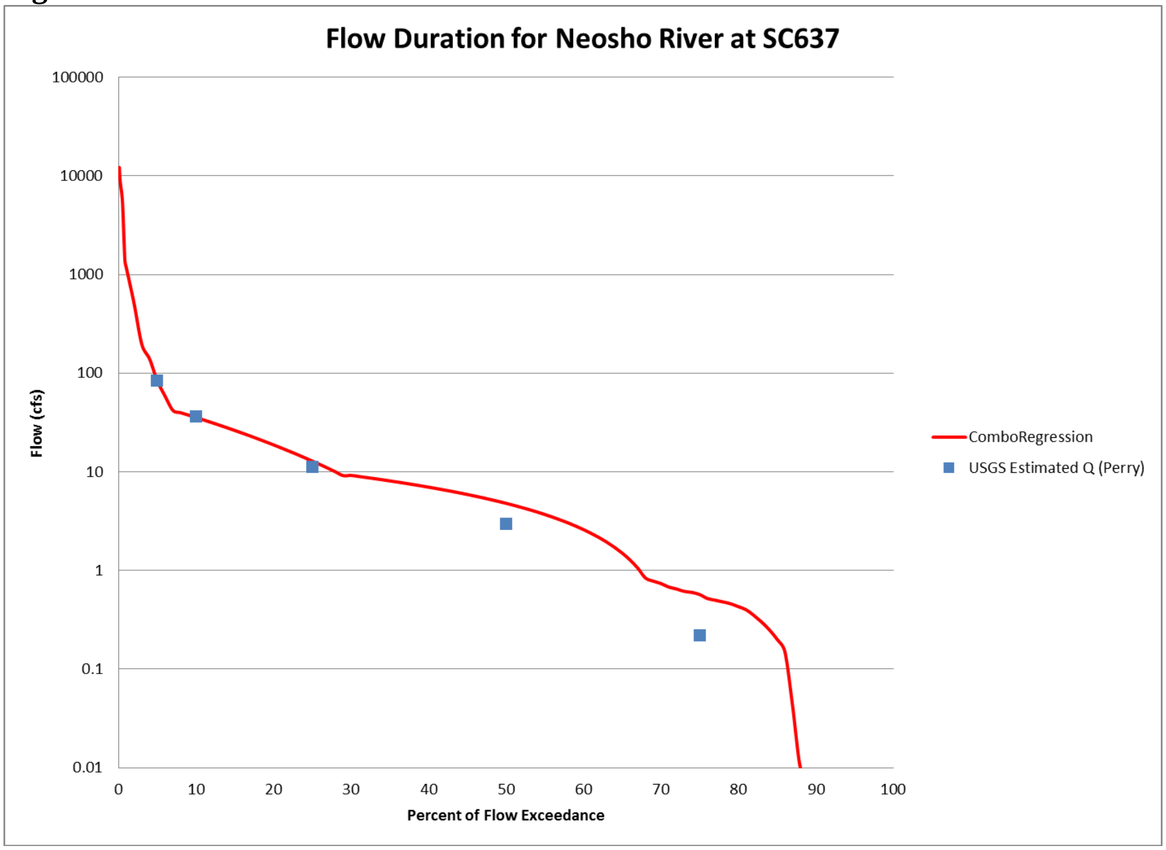


Figure 3. Estimated annual average and median flows at SC637.

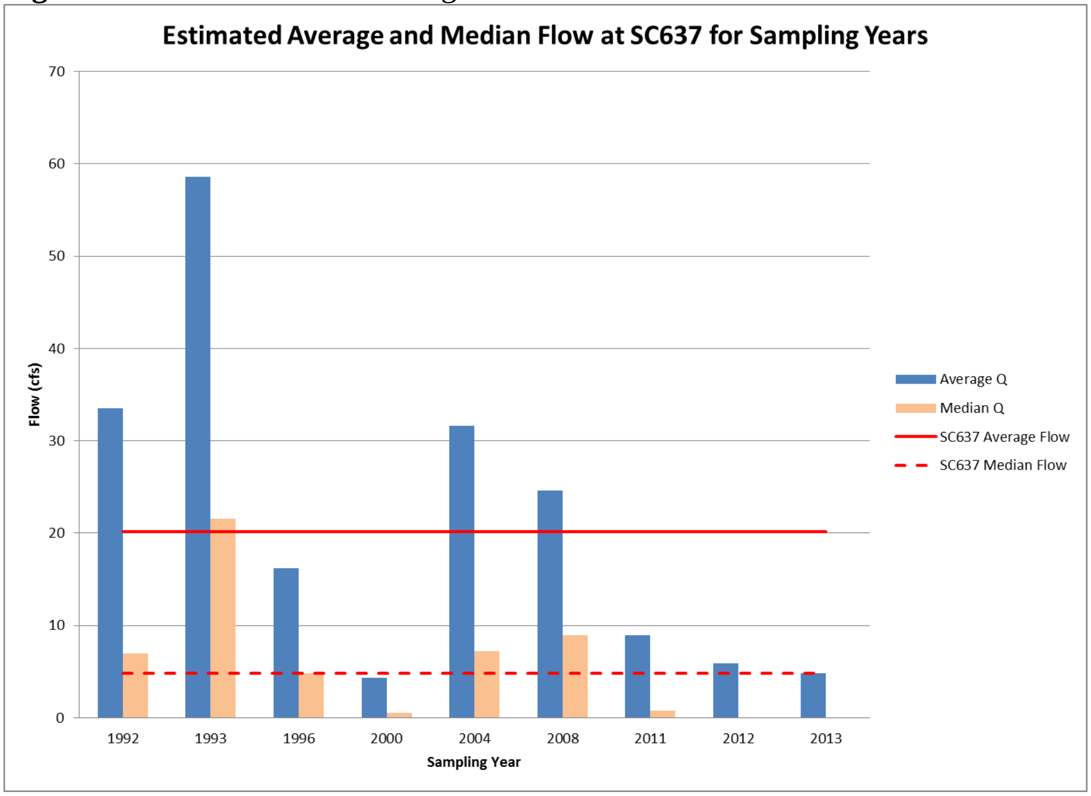
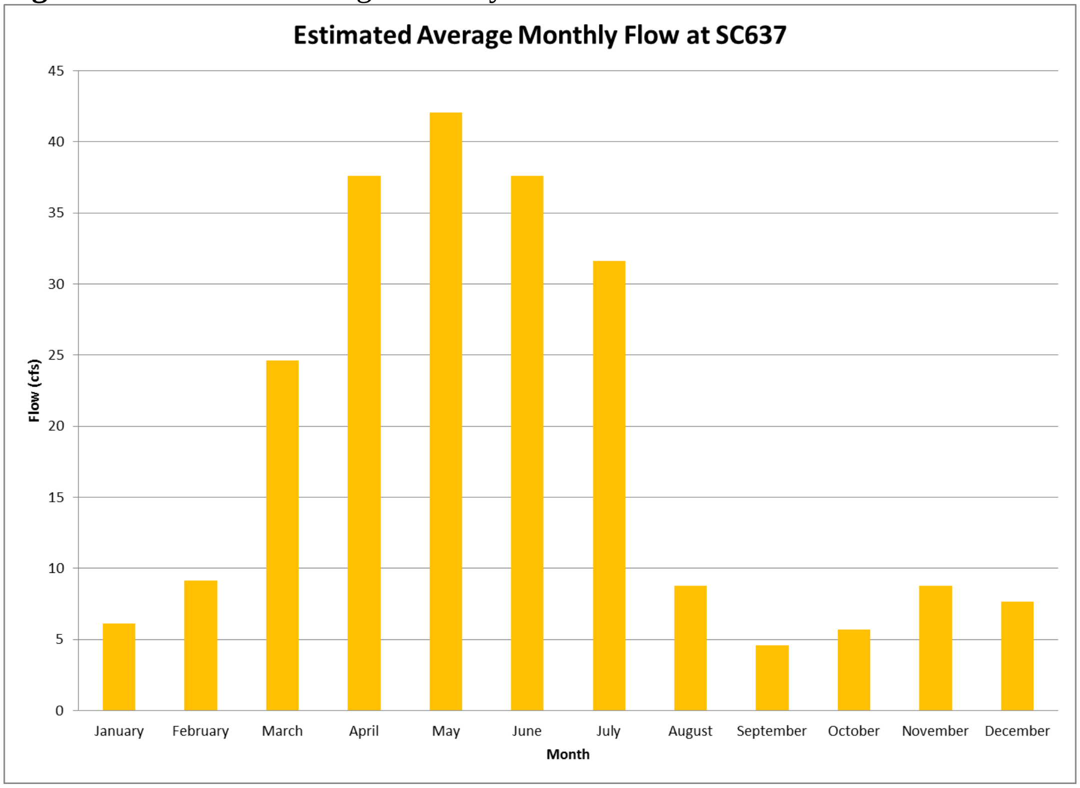


Figure 4. Estimated Average Monthly Flow at SC637.



Assessment Season: Seasonal variability has been accounted for in this TMDL. A three season approach was utilized to include: the Spring season consisting of the months of April, May, and June; the Summer-Fall season consisting of the months of July, August, September, and October, and the Winter season that includes January, February, March, November, and December.

Phosphorus Concentrations: Data from SW015 was combined with SC637 and commonly included with all references to data for SC637 for the data assessment since these sampling locations are identical. The overall Total Phosphorus concentration average at SC637 on the Neosho River is 0.284 mg/L, with a median concentration of 0.259 mg/L. Seasonal TP averages range from a low of 0.227 mg/L in the Winter season to a high of 0.360 mg/L in the Summer-Fall season. Seasonal median concentrations at SC637 are similar between the three seasons, with median concentrations ranging from a low of 0.170 mg/L in the Winter to 0.200 mg/L in the Spring season, to a high of 0.282 mg/L in Winter. Table 2a details the seasonal averages and medians along with seasonal averages of these.

Table 2a. Seasonal TP concentration averages and medians on the Neosho River from the combined data set of SW015 and SC637.

Season	Spring	Summer/Fall	Winter	Overall
Average (mg/L)	0.255	0.360	0.227	0.281
Median (mg/L)	0.200	0.282	0.170	0.217

Table 2b details the average and median TP concentrations based on various flow conditions at SC637. The highest TP concentration average and median relative to flow are during the high flow condition (0-10% flow exceedance) at SC637, with a TP average of 0.611 mg/L and a TP median of 0.640 mg/L during this condition. TP concentrations are the lowest during the normal flow condition (11-80%), with a TP average of 0.235 mg/L and a TP median of 0.217 mg/L. The TP concentrations during the high flow conditions indicate an increase in nonpoint source loading in the watershed during runoff conditions.

Table 2b. Summary of TP data collected at sampling station SC637 by KDHE (includes SW015).

% of Flow Exceedance	TP Avg. (mg/L)	TP Median (mg/L)
0-10 %	0.611	0.640
11-80%	0.235	0.217
81-99%	0.259	0.268
All Data	0.284	0.259

Seasonal TP concentrations based on the flow conditions are further detailed in Table 3 and Figures 5 and 6. The highest TP concentrations are observed during the high flow conditions during the Spring season, followed by the high flow conditions in the Winter and Summer-Fall. The TP concentrations during the normal flow condition are highest during the Summer-Fall season and the lowest during the Winter Season. During the low flow condition (81-99%), TP concentrations are the highest during the Summer-Fall season and the lowest during the Spring Season.

Table 3. Summary of TP concentrations relative to season and flow condition.

% of Flow Exceedance	Spring TP Avg (mg/L)	Sum-Fall TP Avg (mg/L)	Winter TP Avg (mg/L)	All Seasons TP Avg (mg/L)
0-10%	0.64	0.558	0.635	0.611
11-80%	0.204	0.344	0.152	0.235
81-99%	0.139	0.311	0.230	0.259
All Average	0.255	0.360	0.227	0.284
All Median	0.200	0.282	0.170	0.259

Figure 5. Seasonal TP concentration averages based on flow condition at SC637.

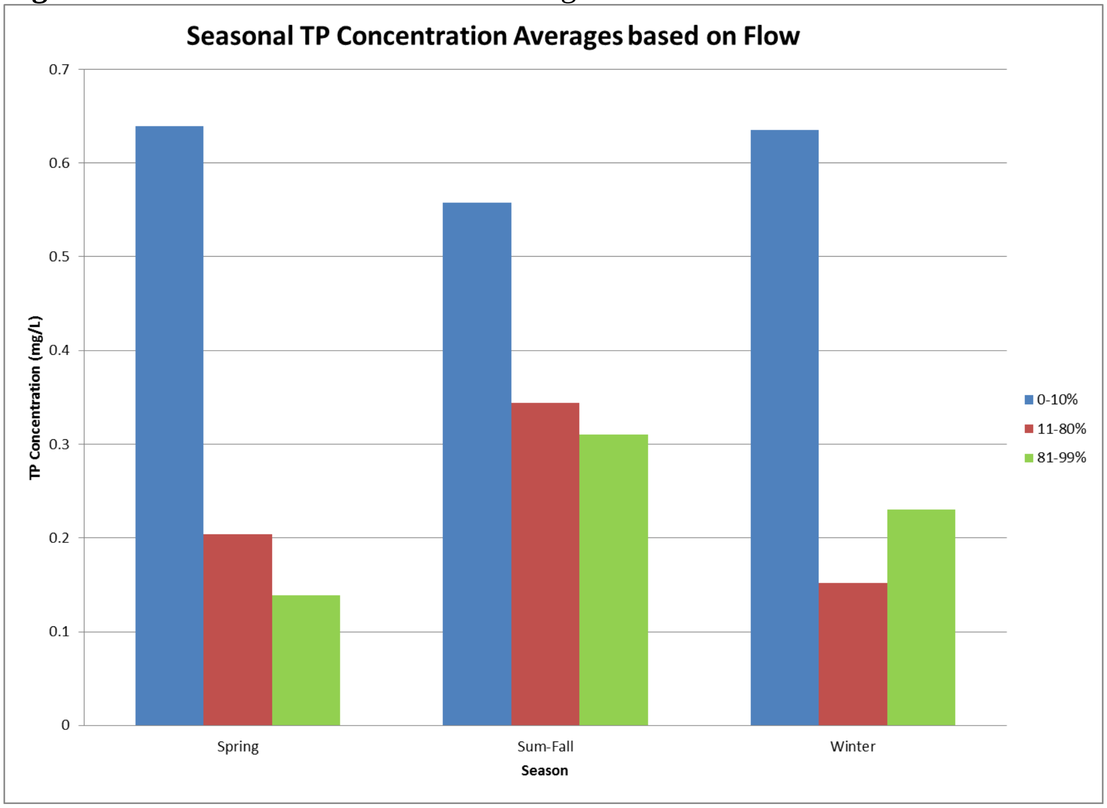
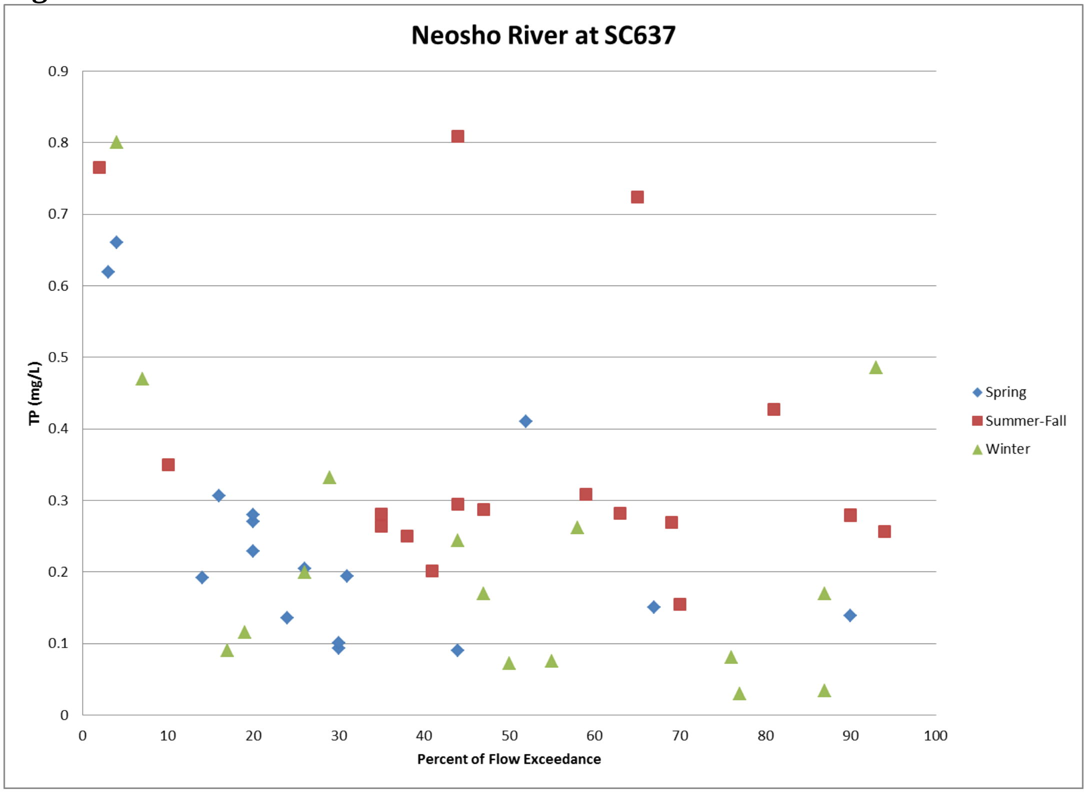


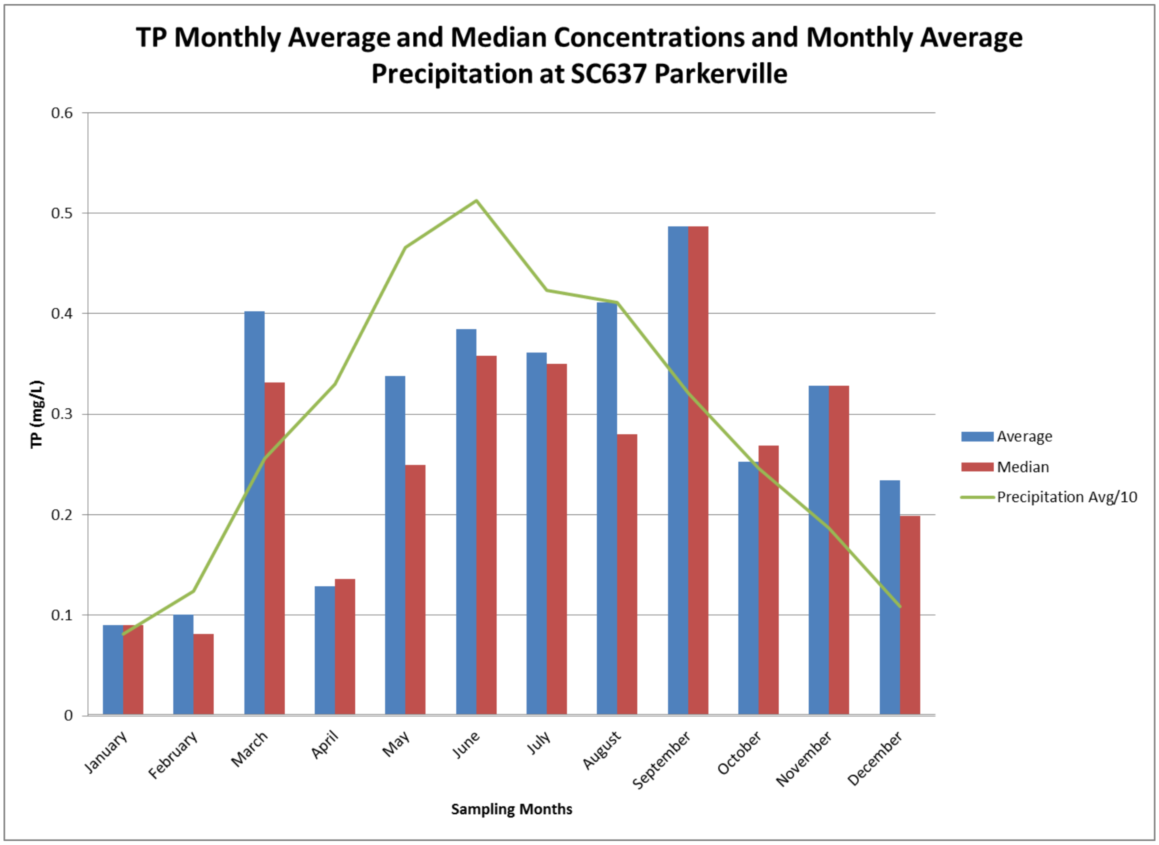
Figure 6. Seasonal TP concentrations relative to flow at SC637.



There are two primary mechanisms in place dictating phosphorus concentrations in the Neosho Headwaters on the Neosho River. The first factor is the influence of nonpoint sources in proximity to the Neosho River and the tributaries in the watershed. The second influence is wet weather sources that dominate loading during runoff events, which includes wet weather impacts of runoff from nonpoint sources in the aftermath of rainfall from areas within the watershed. An additional factor to consider is the seasonal critical condition during the normal and low flow periods, which occur during the summer-fall season.

Monthly average and median TP concentrations at SC637 are detailed and compared to the monthly average precipitation in Figure 7. Higher TP concentrations occur during the warmer months when precipitation averages are higher. This further details that the high TP concentrations are related to nonpoint sources during runoff events associated with prolonged or intense rainfall events.

Figure 7. Monthly average and median TP concentrations and average precipitation at SC637.



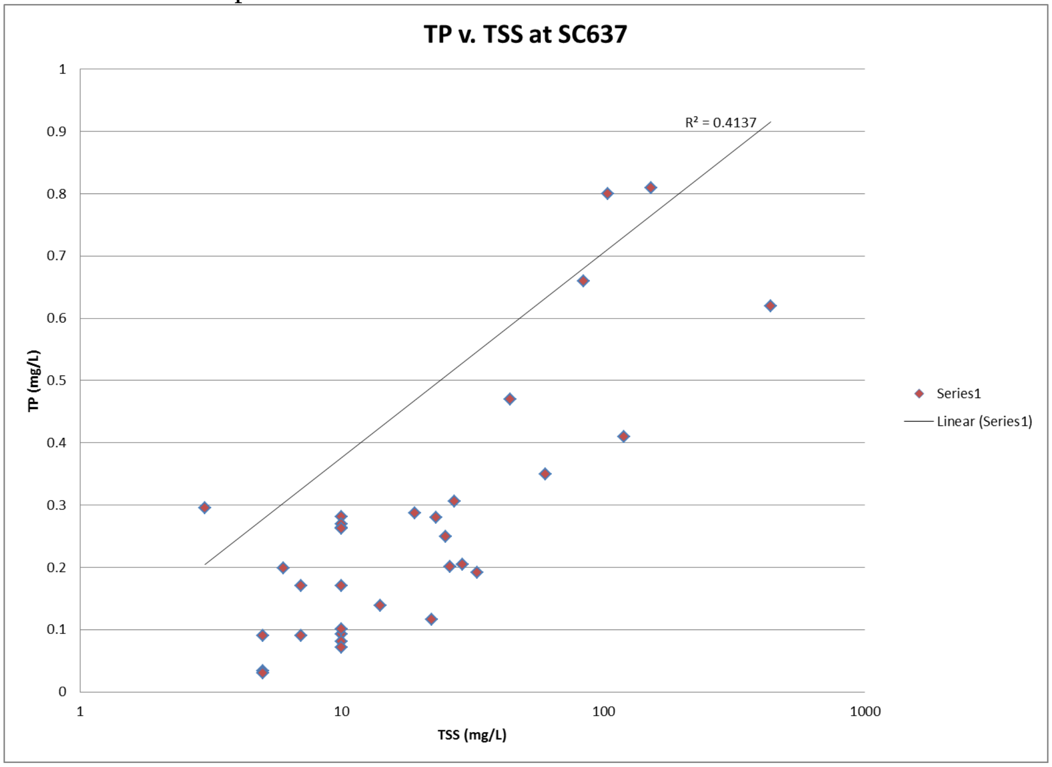
Stream probabilistic sampling data was obtained from Level Creek within the watershed during three sampling events in 2006. Table 4 details the TP concentrations in Level Creek during the 2006 sampling events. The laregest CAFO in the watershed (15,500 head) is located near the headwaters of Level Creek.

Table 4. TP concentrations at probabilistic sampling site SPA067 on Level Creek.

Sampling Date	TP concentration (mg/L)	Estimated % of Flow Exceedance
5/17/2006	0.677	36%
9/20/2006	0.598	77%
11/15/2006	0.299	73%

As Figure 8 details, there is a strong relationship between TP and TSS concentrations, which is typical when nonpoint source loading influences water quality.

Figure 8. Relationship between TP and TSS on the Neosho R at SC637.



The average and median TP concentrations for each of the 68 sampling stations within Ecoregion 28 were compared and summarized. An analyses of TP concentrations within Ecoregion 28 indicates that the average concentration of the station averages is 0.175 mg/L in Ecoregion 28. Table 5 details the percentiles of the TP concentrations for both the summary of the station averages and station medians. Additionally, the Ecoregion 28 station TP data was separated by river basins and evaluated. For station data in the Neosho Basin, the average TP concentration is 0.188 mg/L, the average median concentration is 0.144 mg/L, the 50th percentile median concentration is 0.121 mg/L and the top 25th percentile of the median concentrations is 0.085 mg/L. The summary of the TP data in ecoregion 28 by basin is detailed in Table 6.

Table 5. Ecoregion 28 TP Concentration summary from 68 KDHE stream chemistry stations, totaling 4,672 samples.

Percentile of Data from Ecoregion 28 Stations	From Station Average TP Concentrations (mg/L)	From Station Median TP Concentrations (mg/L)
25th Percentile	0.09	0.06
50th Percentile	0.149	0.103
75th Percentile	0.222	0.182
90th Percentile	0.327	0.280
Average	0.175	0.132

Table 6. Ecoregion 28 Stations TP concentration summary by Basin.

Basin	Number of Stations	TP Average (mg/L)	TP 50th % of the Average (mg/L)	TP Avg of Median (mg/L)	TP 50th % of the Medians (mg/L)	TP 25th % of the Medians (mg/L)
Kansas Lower Republican	26	0.177	0.172	0.127	0.109	0.061
Neosho	26	0.188	0.164	0.144	0.121	0.085
Smoky Hill –Solomon	3	0.278	0.2	0.237	0.201	0.191
Verdigris	7	0.082	0.085	0.052	0.050	0.045
Walnut	6	0.171	0.13	0.138	0.088	0.08

Relationship between Phosphorus and Biological Indicators: The narrative criteria of the Kansas Water Quality Standards are based on indications of the prevailing biological community. Excessive primary productivity may be indicated by extreme swings in dissolved oxygen or pH as the chemical reactions of photosynthesis and respiration alter the ambient levels of oxygen or acid-base balance of a stream. The relationships between pH and stream temperature at SC637 is illustrated in Figure 9a. Higher pH values tend to occur during higher photosynthesis periods. Levels of pH exceeded the criterion of 8.5 at SC637 only one time. The average pH value is 7.76 at SC637, which is within the range of the pH criteria for Kansas waters. Figure 9b illustrates the relationship between pH and the TP concentrations at SC637.

Figure 9a. Relationship between pH and temperature in the Neosho River at SC637.

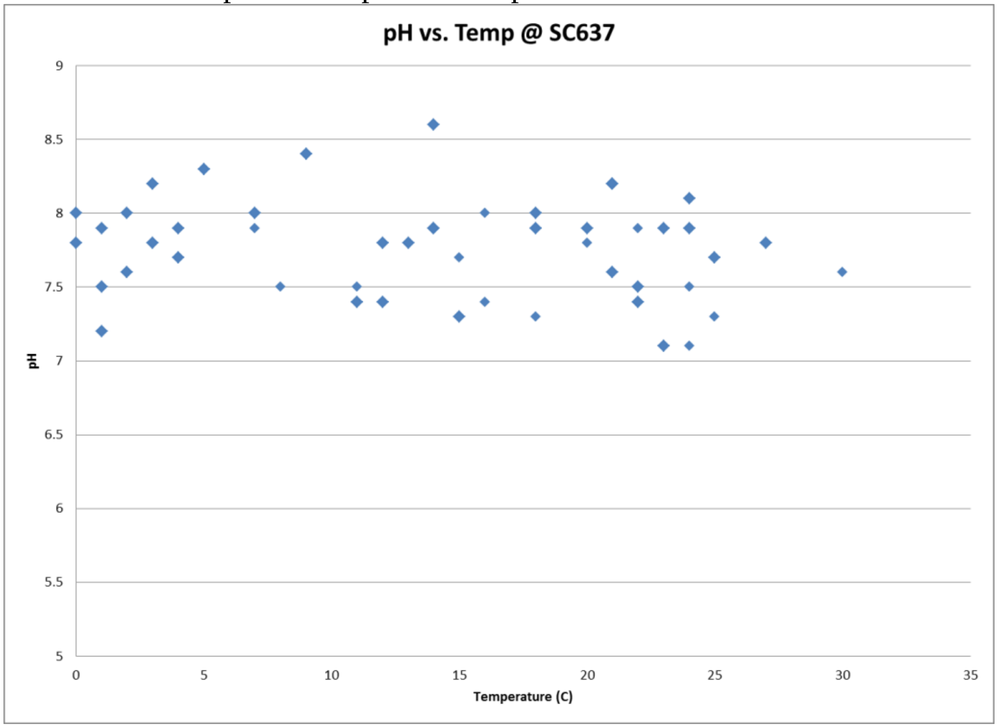
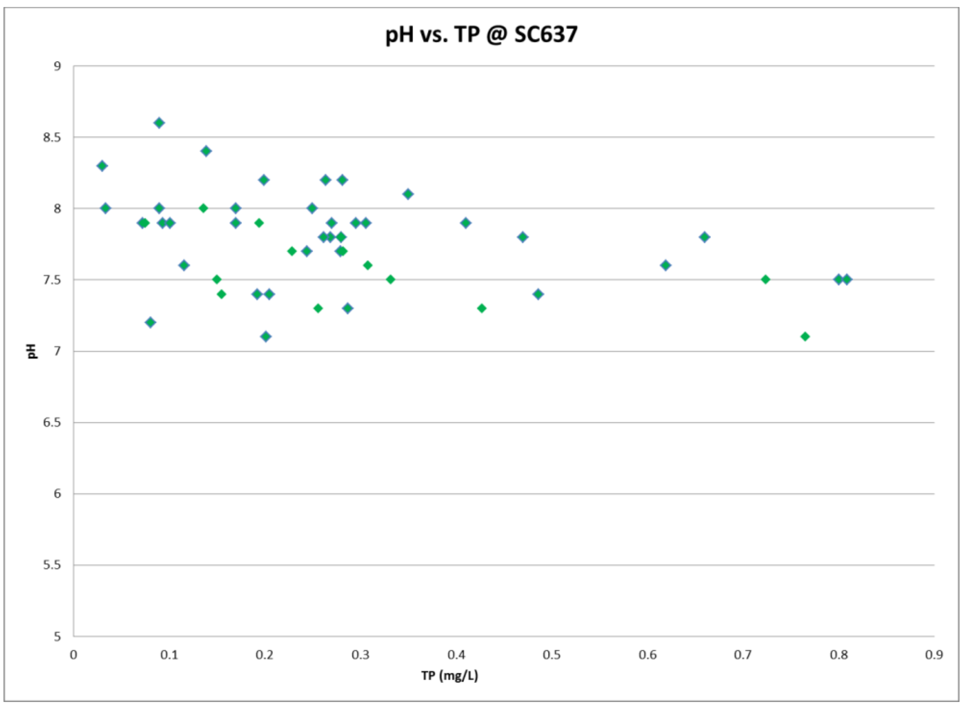


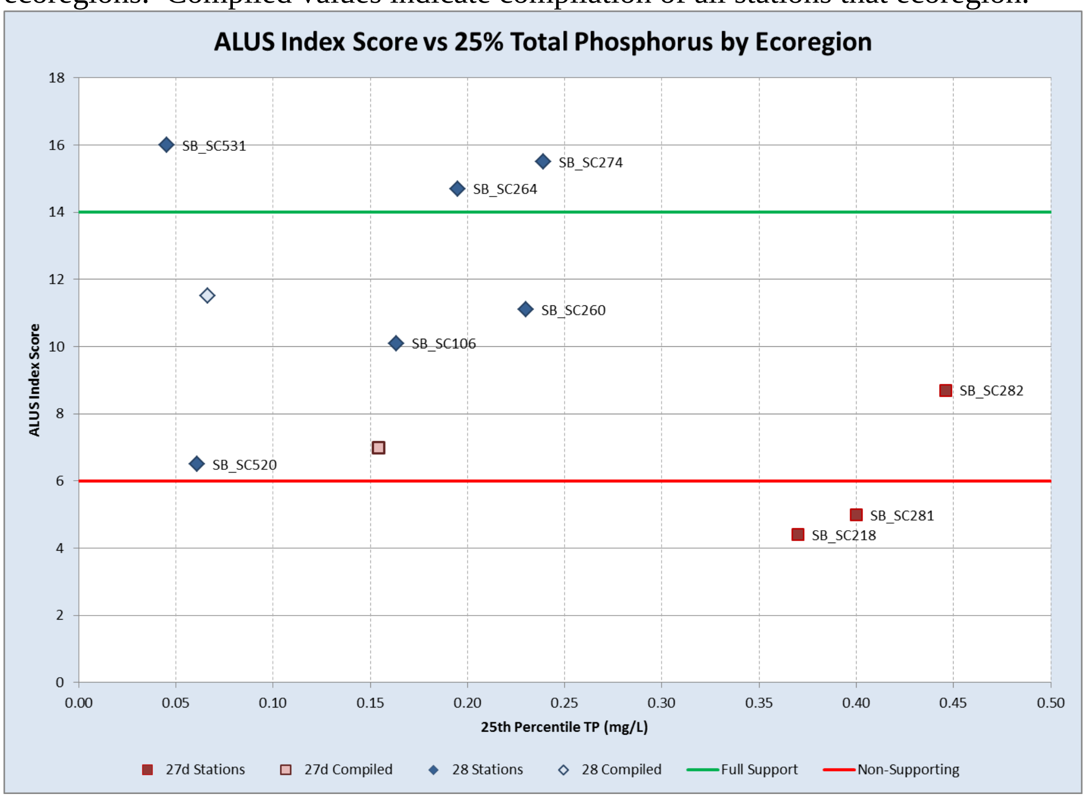
Figure 9b. Relationship between pH and TP concentrations in the Neosho River at SC637.



Current EPA philosophy is predicated on the lowest quartile of stream total phosphorus within an ecoregion as indicative of minimum impact conditions (in absence of reference streams). This generalization is not tied to specific biological conditions, but represents water quality protection policy guiding EPA's administration of clean water programs.

Figure 10 displays the relationship between the lower quartile phosphorus values and ALUS Index scores within the Central Great Plains Wellington-McPherson Lowland (27d) and Flint Hills (28) ecoregions. High ALUS Index scores are indicative of high quality biological communities. Kansas protocol is to delineate the boundaries between full and partial aquatic life support and between partial support and non-support as ALUS Index scores of 14 and 6, respectively. Based on Figure 10, conditions of full support span phosphorus TP levels of 0.045 to 0.239 mg/L while the condition of partial support have a range of phosphorous concentrations from 0.061 to 0.446 mg/L.

Figure 10. ALUS Index scores and the lower 25% total phosphorus levels for stations in the Central Great Palins Wellington-McPherson Lowland (27d) and Flint Hills (28) ecoregions. Compiled values indicate compilation of all stations that ecoregion.



KDHE currently does not sample sestonic chlorophyll at SC637. EPA's guidance on nutrient criteria for streams (2000) indicated trophic issues in stream with over 8-15 µg/l sestonic chlorophyll.

Desired Endpoint: The ultimate endpoint of the TMDL will be to achieve the Kansas Water Quality Standards by eliminating any of the impacts to aquatic life, domestic water supply or recreation associated with excessive phosphorus and objectionable amounts of algae as described in the narrative criteria pertaining to nutrients. There are no existing numeric phosphorus criteria currently in Kansas. The current EPA suggested benchmarks for stream TP in the Great Plains Grass and Shrublands ecoregion is 0.023 mg/L TP over the 10-state aggregate of Level IV ecoregions. The EPA reference condition for Ecoregion IV streams in subecoregion 28 (Flint Hills) for the 25^{th} percentile of data is 0.060 mg/L of TP (EPA, 2001).

The contributing area of the watershed resides in Flint Hills, ecoregion 28. Comparable analysis of data that is restricted to Kansas Stations in the Flint Hills indicates the lower quartile TP value from the station medians is also 0.060 mg/L, equaling the EPA suggested benchmark. If we further narrow the ecoregion value down to the Neosho basin, the 25^{th} % of medians is slightly higher at 0.085 mg/L. The median concentration of the means for the stations within ecoregion 28 and the Neosho Basin is 0.164 mg/L.

The TP concentrations in ecoregion 28 that are associated with an Aquatic Life Use Support Indices (ALUS Index) score greater than 14, have a lower 25^{th} percentile TP concentration that range from 0.045 mg/L to 0.239 mg/L. The large variability is associated with the influence of point sources and the proximity of the dischargers to the sampling locations. The station with the lowest concentration has the highest ALUS index. Biological sampling has not been collected from SC637 on the Neosho River near Parkerville. Future biological sampling will ultimately establish the specific relationship between the ALUS index and TP concentrations within the Neosho headwaters watershed.

The ALUS Index and sestonic chlorophyll concentration will serve to establish if the biological community of the Neosho River headwaters reflects recovery, renewed diversity and minimal disruption by the impacts described in the narrative criteria for nutrients on aquatic life, recreation and domestic water supply. The ALUS Index score consists of five categorizations of biotic conditions:

1. Macroinvertebrate Biotic Index (MBI): A statistical measure that evaluates the effects of nutrients and oxygen demanding substances on macroinvertebrates based on the relative abundance of certain indicator taxa (orders and familites).
2. Ephermeroptera, Plecoptera and Trichoptera (EPT) abundance as a percentage of the total abundance of macroinvertebrates.
3. Kansas Biotic Index for Nutrients (KBI-N): Mathematically equivalent to the MBI, however, the tolerance values are species specific and restricted to aquatic insect orders.
4. EPT Percent of Count (EPT% CNT) – The percentage of organisms in a sample consisting of individuals belonging to the EPT orders.
5. Shannon's Evenness (SHN EVN) – A measure of diversity that describes how evenly distributed the numbers of individuals are among the taxa in a sample.

Once measured, the metrics detailed above are then assigned a score according to Table 7 and the scores are tallied and a support category assigned according to Table 8.

Table 7. ALUS Index metrics with scoring ranges.

MBI	KBI-N	EPT	EPT % CNT	SHN EVN	Score
<= 4.18	<= 2.52	>= 16	>= 65	>= 0.849	4
4.19-4.38	2.53-2.64	14-15	56-64	0.826-0.848	3
4.39-4.57	2.65-2.75	12-13	48-55	0.802-0.825	2
4.58-4.88	2.76-2.87	10-11	38-47	0.767-0.801	1
>= 4.89	>= 2.88	< = 9	<= 37	<= 0.766	0

Table 8. ALUS Index score range, interpretation of biotic condition, and supporting, partial and no supporting categories.

ALUS Index Score	Biotic Condition	Support Category
17-20	Very Good	Supporting
14-16	Good	
7-13	Fair	Partially Supporting
4-6	Poor	Non-supporting
1-3	Very Poor	

Therefore, the numeric endpoints for this TMDL indicating attainment of water quality standards in the watershed will be:

1. An ALUS Index score greater than or equal to 14.
2. Sestonic chlorophyll: The concentration of planktonic algae floating in the water column of the stream. EPA (2000) sestonic chlorophyll levels over 8-15 µg/L are problematic. A target value of 5µg/l will be sought for SC637.

The endpoints have to initially be maintained over three consecutive years to constitute full support of the designated uses of the Neosho River headwaters at SC637. After standards are attained, simultaneous digression of these endpoints more than once every three years, on average, constitutes a resumption of impaired conditions.

The endpoints will be evaluated periodically as phosphorus levels decline over time. This TMDL looks to establish management milestones for phosphorus concentrations that would be the cue to examine the biological conditions of the streams. This TMDL established two milestones to achieve the ultimate endpoint of this TMDL. The first milestone will be a reduction of the median TP concentration at SC637 to **0.164 mg/L**, based on the median of the average TP values of sampling stations within ecoregion 28 and the Neosho Basin. The second milestone will be targeted once the first milestone is reached. The second milestone will be a reduction of the TP median at SC637 to **0.121 mg/L**, reaching a median equal to that of the best 50% of the stations within the ecoregion 28 and Neosho basin stations. Table 9 details the reduction of the current TP median concentration at SC637 to reach these milestones.

Table 9. TP concentration reductions necessary to meet TMDL endpoints.

	Current TP Median (mg/L)	Phase I TMDL (mg/Ll)	Phase I Concentration Reduction	Phase II TMDL (mg/L)	Phase II Concentration Reduction (mg/L)
SC637 Neosho R	0.259	0.164	36.7%	0.121	53.3%

Presuming the first Phase of reducing phosphorus levels in the watershed improves water quality but does not attain the biological indicators, a second phase of implementation will commence. In time, median phosphorus concentrations should approach the median value of the stations within the ecoregion 28 Neosho Basin stations (0.121 mg/L), encompassing all flow conditions.

Achievement of the biological endpoints indicates any loads of phosphorus are within the loading capacity of the stream, water quality standards are attained and full support of the designated uses of the stream has been restored.

3. SOURCE INVENTORY AND ASSESSMENT

Point Sources: There is one permitted NPDES facility located within the watershed. This facility is the White City Wastewater Treatment Plant, which utilizes a three-cell wastewater stabilization lagoon system. This facility currently monitors TP concentrations in their effluent on a quarterly basis, however there has not been any discharge since TP monitoring was added to their permit. The permit summary for this facility is detailed in Table 10. Since 2008, there have only been 14 months when discharge from this facility was reported. TP monitoring has only been a requirement since the most recent permit was issued on April 1, 2013.

Table 10. NPDES permitted facilities in the watershed.

KS Permit #	NPDES #	Facility	Permitted Flow (MGD)	Receiving Stream	Permit Expires
M-NE68-OO02	KS0096873	White City WWTP	0.094	Neosho R via unnamed trib	3/31/2018

Livestock and Waste Management Systems: There are three certified or permitted confined animal feeding operations (CAFOs) within the TMDL watershed. Of these, one is a large federally permitted facility. All of these livestock facilities have waste management systems designed to minimize runoff entering their operation and detain runoff emanating from their facilities. These facilities are designed to retain a 25-year, 24-hour rainfall/runoff event as well as an anticipated two weeks of normal wastewater from their operations. Typically, this rainfall event coincides with streamflow that occurs less than 1-5% of the time. It is unlikely TP loading would be attributable to properly operating permitted facilities, though extensive loading may occur if any of these facilities were in violation and discharged. Table 11 details the facilities within the TMDL watershed.

Table 11. Registered or Permitted Animal Feeding Operations in the watershed.

KS Permit #	NPDES Permit	County	Animal Total	Permit Type	Animal Type
A-NEMR-C001	KS0117218	Morris	15500	Permit	Beef
A-NEMR-BA01	NA	Morris	400	Certification	Beef
A-NEMR-MA04	NA	Morris	20	Certification	Dairy

Though the total potential number of animals is approximately 15,920 head in the watershed, the actual number of animals at the feedlot operations is typically less than the allowable permitted number.

According to the United States Department of Agriculture's (USDA) National Agricultural Statistics Service (NASS) Kansas Farm Facts 2012 report, there were 55,000 head of cattle (including calves) in Morris County. The 2007 Census of Agriculture reported there were 768 horses in Morris County.

On-site Waste Systems: Households outside of the municipalities served by wastewater treatment systems are presumably utilizing on-site septic systems. The Spreadsheet Tool for Estimating Pollutant Load (STEPL) was utilized to identify the number of septic systems within the HUC12s within the watershed. According to STEPL, there are approximately 201 septic systems within the watershed with an anticipated failure rate of 0.93%. Failing on-site septic systems do not likely contribute to the total phosphorus impairment within the watershed.

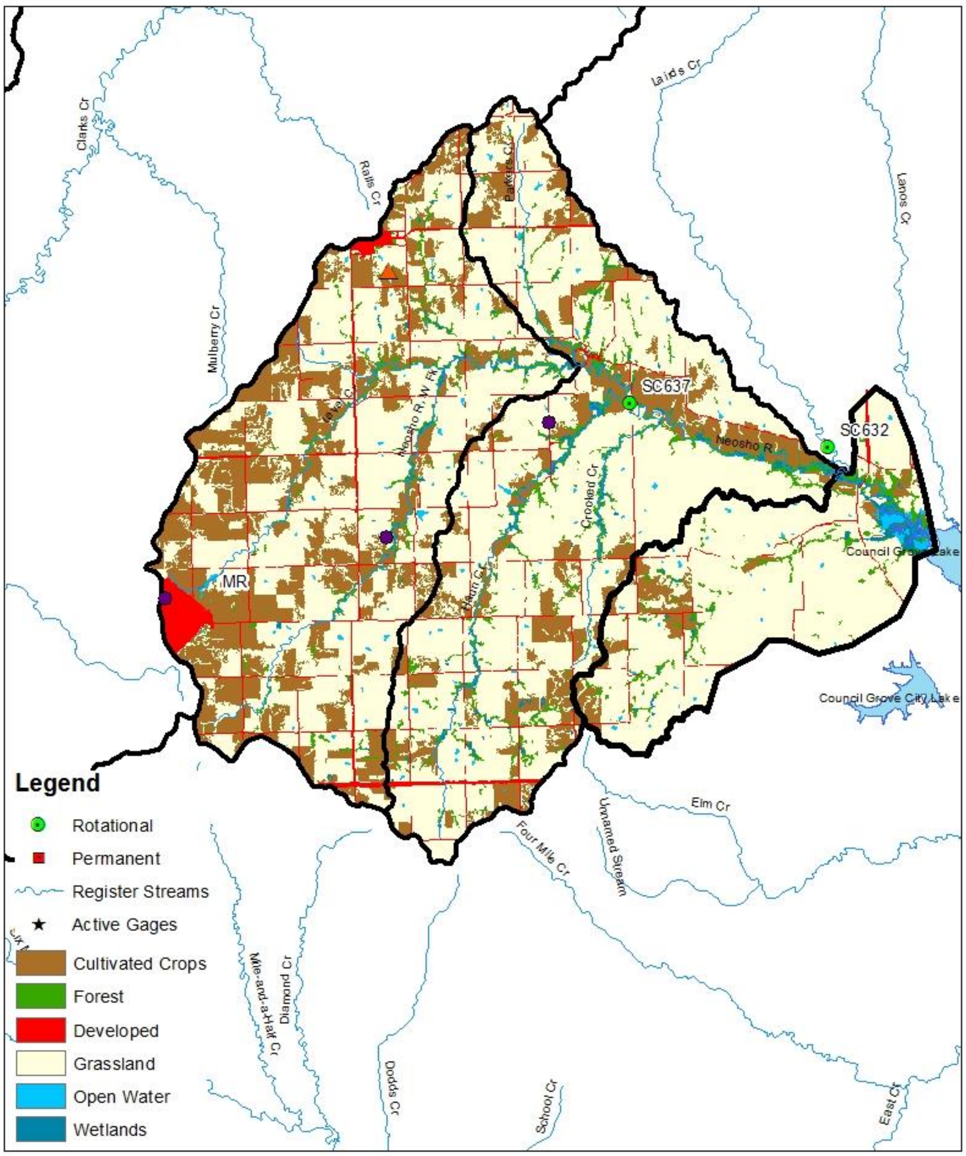
Population Density: According to the 2010 Census information, the watershed has approximately 953 people, with a population density of 12.7 people/square mile. The cities of White City and Parkerville have a population of 618 and 59 people respectively based on the 2010 census. White City had an increase in population from the 2000 census when it reported 518 residents. Parkerville is declining in population as the 2000 census reported 73 residents.

Land Use: Land use within the watershed is dominated by grassland (63.25%) according to the 2001 National Land Cover Data set (NLCD). Cropland and developed areas comprise about 26.02% and 4.78% of the watershed respectively. The land use percentages and acres within the watershed are in Table 12 and are further illustrated in the land use map in Figure 11. As detailed in Figure 11, the location of the cropland within the watershed is in the low lying areas adjacent to the stream corridors. Runoff from the cropland areas could contribute significant sources of total phosphorus loading.

Table 12. Landuse acres and percentages in the TMDL watershed.

Landuse	Acres	% of Area
Grassland	45385	66.24
Cultivated Crops	15725	22.95
Developed	2998	4.38
Forest	2982	4.35
Wetlands	938	1.37
Open Water	484	0.71

Figure 11. Landuse Map for the Neosho Headwaters SC637 watershed.



Contributing Runoff: The TMDL watershed has a mean soil permeability value of 0.24 inches/hour, ranging from 0.01 to 1.29 inches/hour according to the NRCS STATSGO database. About 55% of the watershed has a permeability value less than 0.57 inches/hour, which contributes to runoff during extremely low rainfall intensity events. Whereas 91% of the watershed has a permeability value less than 1.14 inches/hour, which contributes to runoff during very low rainfall intensity events. The entire watershed has a soil permeability less than 1.29 inches/hour. According to an USGS open-file report (Juracek, 2000), the threshold soil permeability values are set at 3.43 inches/hour for very high, 2.86 inches/hour for high, 2.29 inches/hour for moderate, 1.71 inches/hour for low, 1.14 inches/hour for very low, and 0.57 inches/hour for extremely low soil-permeability. As the watersheds' soil profiles become saturated, excess overland flow is produced. The majority of the nonpoint source nutrient runoff will be associated with cropland areas throughout the watershed that are in close proximity to the stream corridors.

Background: Phosphorus is present over the landscape, in the soil profile as well as terrestrial and aquatic biota. Wildlife can contribute phosphorus loadings, particularly if they congregate to a density that exceeds the assimilative capacity of the land or water.

4. ALLOCATION OF POLLUTION REDUCITON RESPONSIBILITY

This TMDL will be established in Phases and Stages to progressively reduce phosphorus loadings and ambient concentrations with periodic assessment of the biological endpoints on the Neosho River. The phases and stages of this TMDL are detailed in Table 13. The initial phase will entail reductions in phosphorus levels of the nonpoint sources associated with the cropland adjacent to the stream corridors. TP load reductions will occur throughout the stream and be monitored at SC637. Reduced upstream TP loading will be indicative as the TP concentrations approach the TP target concentrations, which will result in favorable biological support throughout the stream. Additionally, grassland and livestock management within the watershed should reduce nonpoint source loads under conditions of moderate flows as part of Stage Two.

Once the concentrations at Station SC637 approach the Phase One target of a median TP concentration of 0.164 mg/L, and sestonic chlorophyll < 5 µg/l, an intensive assessment of macroinvertebrate diversity will be made to determine compliance with the narrative nutrient criteria.

Table 13. TP TMDL Phases, Milestones and Actions.

TMDL Phase / Stage	TP Milestone at SC637	Anticipated Actions	Biological Endpoints
I (Nonpoint – Cropland)	0.164 mg/L	Targeted Tributary Riparian Management; Cropland Riparian BMPs, riparian livestock management	ALUS Index Score >=14 Sestonic Chlorophyll < 5 µg/L
II (Nonpoint – Grassland/ Runoff)	0.121 mg/L	Grassland and rangeland BMPs; wet weather runoff BMPs.	

Presuming one or more of the biologic endpoints are not met at the end of Phase One, Phase Two will commence. Additional reductions in loads and phosphorus concentrations will be accomplished through enhanced implementation of controls on non-point sources. The desired target levels are comparable to the median concentrations seen at the ecoregion 28 Neosho River Basin stations. A second intensive biological assessment will be made once phosphorus levels approach that seen at the regional benchmark of 0.121 mg/L of TP. The achievement of the Phase Two milestone, if necessary, will meet all water quality standards and achieve full support for all the biological endpoints.

Point Sources: The Wasteload Allocations (WLA) is associated with the wastewater treatment facility for White City. The WLA for White City is based on the permitted flow (0.094 MGD) with a discharge concentration of 2.0 mg/L, an effluent TP concentration seen from Kansas lagoon systems. The WLA is 1.57 lbs/day of TP.

Nonpoint Source Load Allocation: The load allocation for nonpoint sources is the remaining load capacity after assimilated wasteloads for the NPDES wastewater has been accounted for. Nonpoint sources are assumed to be very minimal during drier conditions when streamflows are less than median flows. The load allocation grows proportionately as streamflow increases. Load capacities and allocations under this TMDL are detailed in Table 14 for Phase I and Table 15 for Phase II. The TMDL has been calculated at SC637 on segment 23 of the Neosho River since attainment of the TMDL will be measured at SC637. The calculated TMDL at the terminus of the watershed covered by this TMDL at the end of segment 23 increases by approximately 29%.

Table 14. Load Capacities and Allocations (lbs/day) under Phase I for Neosho River segment 23 as measured at SC637

SC637				
Percent Flow	Flow (cfs)	Load Capacity	WLA (lbs/day)	LA (lbs/day)
75	0.57	0.50	0.50	0
50	4.8	4.25	1.57	2.68
25	12.86	11.39	1.57	9.82
10	35.55	31.49	1.57	29.92

Figure 12. Neosho River TP TMDL for Neosho River segment 23, as measured at SC637.

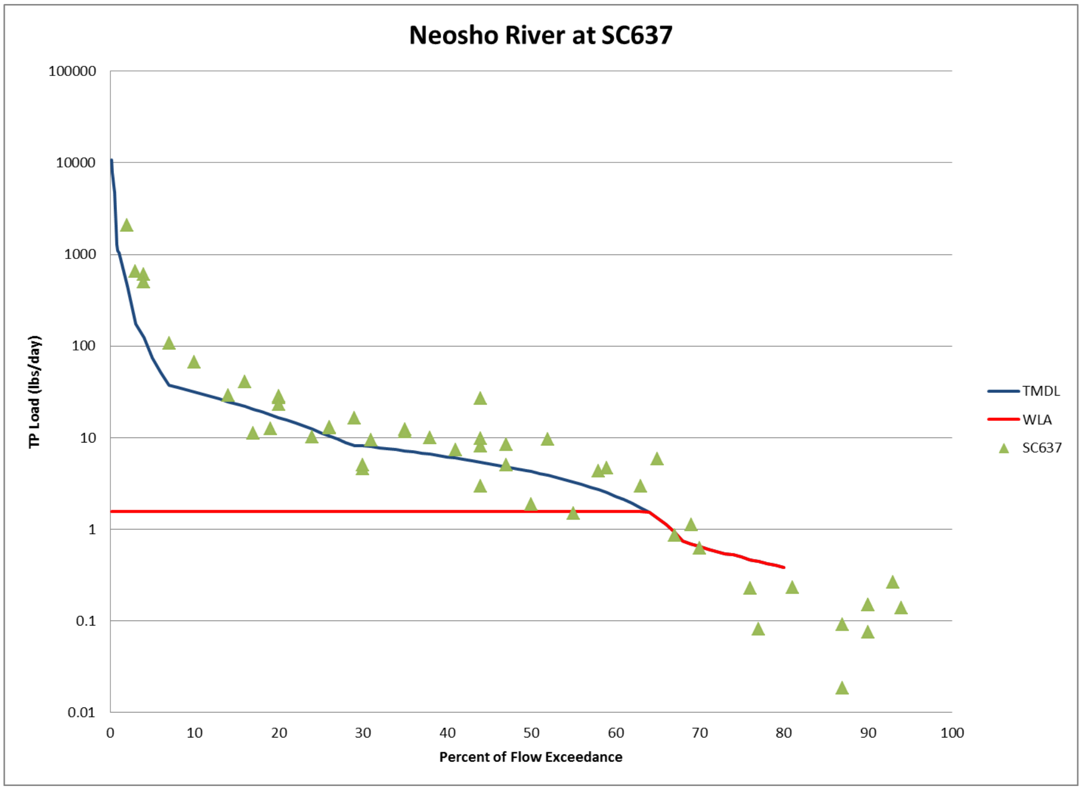


Table 15. Load Capacities and Allocations (lbs/day) under Phase II for Neosho River segment 23 as measured at SC637

SC637				
Percent Flow	Flow (cfs)	Load Capacity	WLA (lbs/day)	LA (lbs/day)
75	0.57	0.37	0.37	0
50	4.8	3.14	1.57	1.57
25	12.86	8.4	1.57	6.83
10	35.55	23.23	1.57	21.66

Defined Margin of Safety: The Margin of Safety provides some hedge against the uncertainty in phosphorus loading into the watershed, predominatly from the point source discharger in the watershed. This TMDL uses an implicit margin of safety, relying on conservative assumption to be assured that future wasteload allocations will not cause further excursion from the nutrient criteria. The City of White City infrequently discharges from their lagoon to the watershed. Additionally, biological endpoints are used to assess the narrative criteria and have to be maintained for three consecutive years before attainment of water quality standards can be claimed.

State Water Plan Implementation Priority: Phase One priority is focused on riparian management along the stream corridors to effectively reduce the phosphorus loading to the watershed adjacent to cropland. Phase Two priorities will expand nonpoint source abatement. Due to the need to reduce the high nutrient loads in the watershed, this TMDL will be High Priority for Implementation.

Nutrient Reduction Framework Priority Reduction Ranking: A portion of this watershed lies within the Neosho Headwaters Subbasin (HUC8 11070201), which is among the top sixteen HUC8s targeted for state action to reduce nutrients.

Priority HUC12s: There are only two HUC12s encompassing the TMDL watershed. Both of these are high priority implementation areas. The priority areas within these HUC12s will be further refined to the riparian corridors of the cropland areas and livestock facilities adjacent to the streams within the watershed.

5. IMPLEMENTATION

Desired Implementation Activities:

1. Implement and maintain conservation farming, including conservation tilling, contour farming, and no-till farming to reduce runoff and cropland erosion.
2. Improve riparian conditions along stream systems by installing grass and/or forest buffer strips along the stream and drainage channels in the watershed.
3. Perform extensive soil testing to ensure excess phosphorus is not applied.
4. Ensure land applied manure is being properly managed and is not susceptible to runoff by implementing nutrient management plans.
5. Install pasture management practices, including proper stock density to reduce soil erosion and storm runoff.
6. Ensure livestock feeding sites and pens are away from streams and waterways to increase filtration and waste removal of manure.
7. Ensure proper on-site waste system operations in proximity to the main stream segments.
8. Ensure that labeled application rates of chemical fertilizers are being followed and implement runoff control measures.
9. Renew state and federal permits and inspect permitted facilities for permit compliance.

10. The stakeholder leadership team for the Twin Lakes WRAPS will coordinate BMPs to address:
    a. Livestock: vegetative filter strips, relocate feeding sites, relocate pasture feeding sites off-stream and alternate watering system.
    b. Cropland: grassed waterways, terraces, conservation crop rotations and water retention structures.

NPDES and State Permits – KDHE

a. Monitor influent into and effluent from the discharging permitted wastewater treatment facilities, continue to encourage wastewater reuse and irrigation disposal and ensure compliance and proper operation to control phosphorous levels in wastewater discharges.
b. Establish applicable permit limits and conditions after 2018.
c. Inspect permitted livestock facilities to ensure compliance.
d. New livestock permitted facilities will be inspected for integrity of applied pollution prevention technologies.
e. New registered livestock facilities with less than 300 animal units will apply pollution prevention technologies.
f. Manure management plans will be implemented, to include proper land application rates and practices that will prevent runoff of applied manure.

Nonpoint Source Pollution Technical Assistance – KDHE

a. Support Section 319 implementation projects for reduction of phosphorus runoff from agricultural activities as well as nutrient management.
b. Provide technical assistance on practices geared to the establishment of vegetative buffer strips.
c. Provide technical assistance on nutrient management for livestock facilities in the watershed and practices geared toward small livestock operations, which minimize impacts to stream resources.
d. Support the implementation efforts of the Twin Lakes WRAPS and incorporate long-term objectives of this TMDL into their 9-element watershed plan.

Water Resource Cost Share and Nonpoint Source Pollution Control Program-KDA-DOC

a. Apply conservation farming practices and/or erosion control structures, including no-till, terraces, and contours, sediment control basins, and constructed wetlands.
b. Provide sediment control practices to minimize erosion and sediment transport from cropland and grassland in the watershed.
c. Install livestock waste management systems for manure storage.
d. Implement manure management plans.

Riparian Protection Program – KDA-DOC

a. Establish or re-establish natural riparian systems, including vegetative filter strips and streambank vegetation.
b. Develop riparian restoration projects along targeted stream segments, especially those areas with baseflow.
c. Promote wetland construction to reduce runoff and assimilate sediment loadings.
d. Coordinate riparian management within the watershed and develop riparian restoration projects.

Buffer Initiative Program – KDA-DOC

a. Install grass buffer strips near streams.
b. Leverage Conservation Reserve Enhancement Program to hold riparian land out of production.

Extension Outreach and Technical Assistance – Kansas State University

a. Educate agricultural producers on sediment, nutrient, and pasture management.
b. Educate livestock producers on livestock waste management, land applied manure applications, and nutrient management planning.
c. Provide technical assistance on livestock waste management systems and nutrient management planning.
d. Provide technical assistance on buffer strip design and minimizing cropland runoff.
e. Encourage annual soil testing to determine capacity of field to hold phosphorus.
f. Educate resident, landowners, and watershed stakeholders about nonpoint source pollution.
g. Promote and utilize the WRAPS efforts for pollution prevention, runoff control and resource management. The WRAPS coordinator is also an extension watershed specialist that will provide technical assistance and outreach to producers for BMP implementation. Other entities for this task include NRCS and local conservation districts.

Timeframe for Implementation: Pollutant reduction practices should be installed within the priority subwatersheds before 2017, with follow-up implementation over 2018-2022. If biological conditions warrant, Phase Two will begin in 2028 and continue through 2038.

Targeted Participants: The primary participants for implementation will be the agricultural and livestock producers operating immediately adjacent to the Neosho River and its tributaries. Watershed coordinators and technical staff of the WRAPS, along with Conservation District personnel and county extension agents should assess possible sources adjacent to streams. Implementation activities to address nonpoint sources should focus on those areas with the greatest potential to impact nutrient concentrations adjacent to these creeks.

Targeted Activities to focus attention toward include:
1. Overused grazing land adjacent to the streams.
2. Sites where drainage runs through or adjacent to livestock areas.
3. Sites where livestock have full access to the stream as a primary water supply.
4. Poor riparian area and denuded riparian vegetation along the stream.
5. Unbuffered cropland adjacent to the stream.
6. Conservation compliance on highly erodible areas.
7. Total row crop acreage and gully locations.
8. High-density urban and residential development in proximity to streams and tributary areas.

Milestone for 2022: In accordance with the TMDL development schedule for the State of Kansas, the year 2022 marks the next review of the 303(d) activities in the Neosho Basin. At that point in time, phosphorus data from SC637 should show indications of declining concentrations relative to the pre-2014 data, particularly during normal flow conditions.

Delivery Agents: The primary delivery agents for program participation will be KDHE, and the Twin Lakes WRAPS.

Reasonable Assurances:
Authorities: The following authorities may be used to direct activities in the watershed to reduce pollution:

1. K.S.A. 65-164 and 165 empowers the Secretary of KDHE to regulate the discharge of sewage into the water of the state.

2. K.S.A. 65-117d empowers the Secretary of KDHE to prevent water pollution and to protect the beneficial uses of the waters of the state through required treatment of sewage and established water quality standards and to require permits by persons having a potential to discharge pollutants into the waters of the state.

3. K.S.A. 2002 Supp. 82a-2001 identifies the classes of recreation use and defines impairment for streams.

4. K.A.R. 28-16-69 through 71 implements water quality protection by KDHE through the establishment and administration of critical water quality management areas on a watershed basis.

5. K.S.A. 2-1915 empowers the Kansas Department of Agriculture, Division of Conservation to develop programs to assist the protection, conservation and management of soil and water resources in the state, including riparian areas.

6. K.S.A. 75-5657 empowers the Kansas Department of Agriculture, Division of Conservation to provide financial assistance for local project work plans developed to control nonpoint source pollution.

7. K.S.A. 82a-901, et. seq. empowers the Kansas Water Office to develop a state water plan directing the protection and maintenance of surface water quality for the waters of the state.

8. K.S.A. 82a-951 creates the State Water Plan Fund to finance the implementation of the Kansas Water Plan, including selected Watershed Restoration and Protection Strategies.

9. The Kansas Water Plan and the Neosho Basin Plan provide the guidance to state agencies to coordinate programs intent on protecting water quality and to target those programs to geographic areas of the state for high priority implementation.

Funding: The State Water Plan annually generates $16-18 million and is the primary funding mechanism for implementing water quality protection and pollution reduction activities in the state through the Kansas Water Plan. The state water planning process, overseen by the Kansas Water Office, coordinates and directs programs and funding toward watershed and water resources of highest priority. Typically, the state allocates at least 50% of the fund to programs supporting water quality protection. This watershed and its TMDL are located within a High Priority WRAPS area and should receive support for pollution abatement practices that lower the loading of sediment and nutrients.

Effectiveness: Nutrient control has been proven effective through conservation tillage, contour farming and use of grass waterways and buffer strips. In addition, the proper implementation of comprehensive livestock waste management plans has proven effective at reducing nutrient runoff associated with livestock facilities.

6. MONITORING

Future stream sampling will continue to occur on a rotational basis with quarterly samples collected every four years at sampling stations SC637. The monitoring will include the initiation of sestonic chlorophyll sampling with the next sampling year to be conducted in 2016 at SC637. WRAPS sampling site SW015, located at the SC637 sampling site, will continued to be sampled every year four or five times per year from March through October. It is being recommended for the WRAPS to add sestonic chlorophyll to the parameters they sample for at SW015. Monitoring of tributary levels of TP during runoff events will help direct abatement efforts toward major nonpoint sources.

Commencing in 2017, macroinvertebrate sampling will occur at accessible locations on the Neosho River within the watershed. The streams will be evaluated for possible delisting after Phase One implementation in 2024. If the biological endpoints are achieved over 2019-2023, the conditions described by the narrative nutrient criteria will be viewed as attained on the Neosho River at SC637 and will be moved to Category 2 on the 2024-303(d) list. If they are not, Phase Two of this TMDL begins in 2024.

Once the water quality standards are attained, the adjusted ambient phosphorus concentrations on the Cottonwood and Neosho Rivers will be the basis for establishing numeric phosphorus criteria through the triennial water quality standards process to protect the restored biological and chemical integrity of the rivers.

7. FEEDBACK

Public Notice: An active Internet Web site is established at http://www.kdheks.gov/tmdl/planning_mgmt.htm to convey information to the public on the general establishment of TMDLs and specific TMDLs for the Neosho Basin.

Public Hearing: A public Hearing on this TMDL was held on August 28, 2014 in Emporia to receive public comments. No comments were received regarding this TMDL.

Basin Advisory Committee: The Neosho River Basin Advisory Committee met to discuss the TMDLs in the basin on March 6, 2014 in Marion and on September 24th in Galena.

Milestone Evaluation: In 2022, evaluation will be made as to the degree of implementation that occurred within the watershed. Subsequent decisions will be made through the WRAPS, regarding the implementation approach and follow up of additional implementation in the watershed.

Consideration for 303(d) Delisting: The Neosho River at SC637 will be evaluated for delisting under Section 303(d), based on the monitoring data over the period 2015-2023. Therefore, the decision for delisting will come about in the preparation of the 2024-303(d) list. Should modifications be made to the applicable water quality criteria during the ten-year implementation period, consideration for delisting, desired endpoints of this TMDL and implementation activities may be adjusted accordingly.

Incorporation into Continuing Planning Process, Water Quality Management Plan and he Kansas Water Planning Process: Under the current version of the Continuing Planning Process, the next anticipated revision would come in 2015, which will emphasize implementation of WRAPS activities. At that time, incorporation of this TMDL will be made into the WRAPS plan. Recommendations for this TMDL will be considered in the *Kansas Water Plan* implementation decisions under the State Water Planning Process for Fiscal Years 2015-2023.

Rev. March 10, 2015

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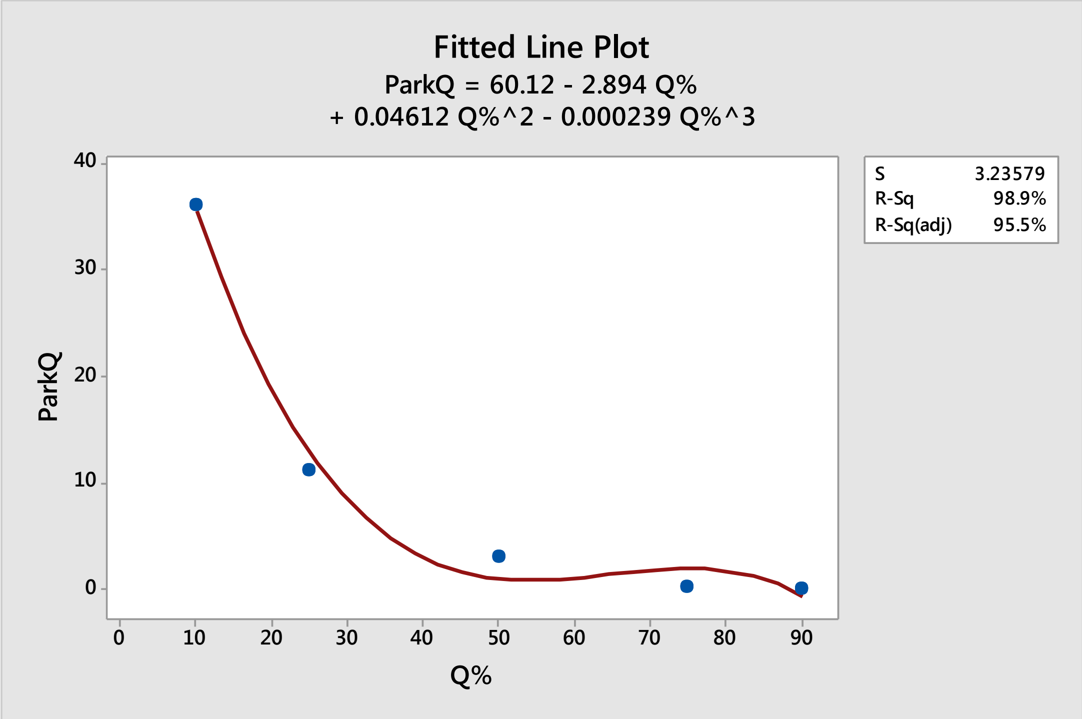
Appendix A.

Long Term Flow Calculations for Flow at SC637 was calculated as follows:

% Flow Exceedance Range	Calculation
0-6%	Calculated from Ratio of observed long term flows at USGS 06888500 from 1990-2014 and flows at USGS 06888500 from 2012-2014. Calculated ratio multiplied by the actual USGS 07179300 flows at Parkerville 2012-2014.
7-29%	Cubic Regression of Flows between USGS 07179300 and USGS Perry flows
30-68%	Linear Regression of Flows between USGS 07179300 and USGS Perry Flows
69-80%	Actual USGS 07179300 % Flow Exceedance Values from recent flow (2012-2014)
81-99.9%	Best Professional Judgment Estimated Values

Appendix A Figure I. Cubic Regression between USGS 07179300 and USGS Perry.



Appendix A Figure II. Linear Regression between USGS 07179300 and USGS Perry.